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Abstract

What accounts for cross-country heterogeneity in exchange rate responses to U.S. monetary policy shocks? Using high-frequency data around Federal Open Market Committee (FOMC) announcements, we document that countries with deeper financial markets—proxied by the size of foreign portfolio liabilities—experience larger currency depreciations following U.S. monetary tightening. This effect is particularly strong for forward guidance shocks relative to conventional interest rate surprises. To rationalize these findings, we extend the gradual portfolio adjustment model by introducing a forward-looking news shock and allowing portfolio adjustment costs to decline with financial market depth. The model replicates our empirical findings, offering a unified explanation for heterogeneous short-run exchange rate dynamics.

Keywords: Exchange rates; Monetary policy spillovers; Portfolio adjustment frictions; Forward guidance; Daily data

JEL Classification: E52; F31; F41; G11; G17

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1 Introduction

Spillovers from the U.S. monetary policy to the rest of the world have long attracted the attention of both academics and policymakers, reflecting the United States' outsized role in the global financial system. In particular, exchange rates—often the first line of defense for open economies with flexible exchange rate regimes—have been extensively studied in response to foreign monetary policy shocks (e.g., Maćkowiak (2007); Georgiadis (2016); Dedola et al. (2017); Iacoviello and Navarro (2019); Albrizio et al. (2020); Bhattarai et al. (2021); Ha (2021); Hoek et al. (2022)).

Most of the literature has examined exchange rate behavior at business cycle frequency, motivated by interest in macroeconomic spillovers. However, such approaches often face identification challenges due to endogeneity in monetary policy shocks, particularly when relying on exclusion restrictions (see Kim and Roubini (2000); Faust et al. (2003); Scholl and Uhlig (2008); Kim et al. (2017)). Studying the high-frequency response of exchange rates to monetary policy is equally important. It enables empirical tests of theoretical predictions, such as uncovered interest parity (UIP), allows for the assessment of market efficiency, and has implications for capital flow management and monetary policy design.

This paper investigates the short-run impact of U.S. monetary policy on global exchange rates, with a particular focus on heterogeneity across countries. Using an event-study framework centered on Federal Open Market Committee (FOMC) announcements, we estimate exchange rate responses within a daily frequency. Focusing on short-run dynamics mitigates concerns that observed heterogeneity reflects endogenous policy responses by foreign central banks (e.g., Taylor (2001); Hnatkovska et al. (2016); Choi et al. (2024)).

We also distinguish between conventional and unconventional monetary policy shocks. To capture the shift in the Federal Reserve's approach under the zero lower bound, we follow Swanson (2021) who constructed surprise components for both the federal funds rate (FFR) and forward guidance (FG). Our analysis therefore relates to recent studies employing high-frequency identification of exchange rate effects (e.g., Rosa (2011); Aizenman et al. (2016);

Inoue and Rossi (2019); Gürkaynak et al. (2021); Miranda-Agrippino and Nenova (2022); Georgiadis and Jarocinski (2023); Albagli et al. (2024)).

Compared to the existing studies, our contribution is to highlight the role of market depth—measured by the size of foreign portfolio liabilities—in shaping the magnitude of exchange rate responses both empirically and theoretically. We find two main empirical results. First, economies with larger foreign liabilities experience greater exchange rate depreciation in response to contractionary U.S. monetary policy shocks. Second, this effect is driven primarily by forward guidance shocks, rather than federal funds rate shocks.

Neither FFR nor FG shocks yield anomalous responses, lending support to the credibility of our identification strategy. Moreover, the prominence of FG shocks is consistent with the forward-looking nature of exchange rates, which respond not only to current but also to expected future interest rate differentials (Engel (2016); Galí (2020)).

We show that our results remain robust to a battery of alternative explanations. These include the net foreign asset position (Adler et al. (2016); Gardberg (2022)), invoicing currency shares (Zhang (2022); Ca'Zorzi et al. (2023)), foreign reserve holdings (Chen et al. (2016); Ahmed et al. (2023)), and foreign exchange market intervention (Kim (2003); Albagli et al. (2024)).

Given that deeper financial markets are more prevalent in advanced economies, our findings may appear inconsistent with the frequent observation that emerging markets are more vulnerable to U.S. monetary policy spillovers (Maćkowiak (2007); Georgiadis (2016); Iacoviello and Navarro (2019); Albrizio et al. (2020); Bräuning and Ivashina (2020); Aizenman et al. (2024)). However, this tension is resolved by the difference in frequency: our analysis focuses on daily exchange rate movements, whereas most existing studies examine lower-frequency outcomes. We argue that high-frequency dynamics are shaped primarily by portfolio adjustment frictions, while longer-run outcomes reflect structural macroeconomic fundamentals.

To rationalize our empirical findings, we extend the gradual portfolio adjustment model of Bacchetta and Van Wincoop (2021) to include an inverse relationship between market depth and portfolio adjustment costs. This assumption is well-supported by microstructure theory, which links transaction costs to market liquidity (Demsetz (1968); Stoll (2000)). We also incorporate a forward guidance shock as a news shock to future interest rates. The model predicts that currencies of countries with larger external liabilities depreciate more on impact following U.S. monetary tightening. Moreover, the role of external liabilities is greater for news shocks compared to spot interest rate shocks. These dynamics match our empirical results and offer a theoretical explanation for why exchange rates in financially deep economies are more sensitive to U.S. monetary policy at high frequencies.

Our analysis contributes to the literature on exchange rate behavior under frictions, including financial adjustment costs (Bacchetta and Van Wincoop (2010); Gabaix and Maggiori (2015)) and information frictions (Gourinchas and Tornell (2004); Candian (2019); Müller et al. (2024)). These mechanisms help reconcile longstanding puzzles, such as delayed overshooting and the forward premium anomaly. While our model introduces only minimal departures from the standard framework, it successfully captures heterogeneity in both short- and longer-run exchange rate responses.

The remainder of the paper is organized as follows. Section 2 presents our empirical strategy, results, and robustness checks. Section 3 develops the theoretical model and maps its predictions to the data. Section 4 concludes.

2 Empirical Analysis

2.1 Empirical model and data

We estimate the short-run effects of U.S. monetary policy shocks on bilateral exchange rates using an event study framework. Specifically, we examine exchange rate movements relative to the U.S. dollar around the release dates of Federal Open Market Committee (FOMC) statements. To assess heterogeneity across countries, we allow the exchange rate response to vary with each country's foreign liabilities. The baseline regression specification is:

$$
\begin{aligned}
\Delta E_{i,t}^{h} = {} & \beta_0 + \beta_1 MPS_t^{orth} + \gamma_1 MPS_t^{orth} \times liab_{i,y-1} + \alpha_1 liab_{i,y-1} \\
& + \delta_1 size_{i,y-1} + \delta_2 GDPPC_{i,y-1} + \delta_3 \Delta RGDP_{i,y} + \delta_4 openess_{i,y} + \delta_5 D.regime_{i,ym} \\
& + \eta_1 \Delta VIX_t^h + D.year + D.country + \epsilon_{i,t}^{h},
\end{aligned}
\tag{1}
$$

where $\Delta E_{i,t}^{h}$ denotes the percentage change in the nominal exchange rate of country i (relative to the U.S. dollar) from one day before the FOMC announcement to h days after. Formally, $\Delta E_{i,t}^{h} = \frac{e_{i,t+h} - e_{i,t-1}}{e_{i,t-1}} \times 100$, where $e_{i,t}$ is the local currency price of one USD; thus, an increase in $e_{i,t}$ implies a depreciation of currency i. Daily exchange rate data are obtained from the Bank for International Settlements (BIS).

To isolate exogenous monetary shocks, we use the monetary policy surprise series MPS_t^{orth} from Bauer and Swanson (2023), which is further orthogonalized to macroeconomic fundamentals and financial conditions that might independently influence exchange rates. This measure addresses endogeneity concerns, given that monetary policy decisions often respond to contemporaneous economic information. We then interact our monetary policy shock variable with $liab_{i,y-1}$ to test the key hypothesis of the paper. To mitigate reverse causality, we use the end-of-year foreign liabilities from the prior year, where y denotes the year of the FOMC meeting due to the annual availability of cross-country foreign liability data. Foreign liability data, sourced from the International Monetary Fund (IMF)'s International Financial Statistics, are converted to real USD using the U.S. consumer price index (CPI) and transformed using natural logarithms. To ease the economic interpretation of its interaction with the U.S. monetary policy shock, this variable is demeaned for normalization in the estimation.

We control for several country-specific characteristics that may influence exchange rate dynamics. These include: (i) the log of real Gross Domestic Product (GDP) ($size_{i,y-1}$), (ii) log of real GDP per capita ($GDPPC_{i,y-1}$), and (iii) annual real GDP growth ($\Delta RGDP_{i,y}$), all from the World Bank's World Development Indicators (WDI). We also include measures of capital account openness ($openess_{i,y}$), scaled from 0 (fully open) to 1 (fully closed), from Fernandez et al. (2016), and the exchange rate regime classification ($D.regime_{i,ym}$), which varies monthly and is sourced from Ilzetzki et al. (2019). The classification includes crawling pegs, managed floats, and free floats.

To capture global financial conditions, we control for changes in financial market volatility via the VIX index: $\Delta VIX_t^h = \frac{VIX_{t+h} - VIX_{t-1}}{VIX_{t-1}} \times 100$. VIX data are obtained from the Federal Reserve Economic Data (FRED). Country and year-fixed effects are included to absorb any time-invariant country-specific factors and global shocks that may affect exchange rates.

To distinguish the effects of conventional versus unconventional monetary policy, we follow Swanson (2021), who construct orthogonalized factors representing distinct policy instruments. These include shocks to the federal funds rate (FFR_t), forward guidance (FG_t), and large-scale asset purchases ($LSAP_t$), extracted from a principal component decomposition of high-frequency financial data around FOMC announcements.[1] We focus on FFR_t and FG_t, omitting $LSAP_t$ due to the rarity of quantitative tightening episodes in our sample.

The extended regression model is:

$$\begin{aligned}\Delta E_{i,t}^h = {} & \beta_0 + \beta_1 FFR_t + \beta_2 FG_t + \gamma_1 FFR_t \times liab_{i,y-1} + \gamma_2 FG_t \times liab_{i,y-1} + \alpha_1 liab_{i,y-1} \\ & + \delta_1 size_{i,y-1} + \delta_2 GDPPC_{i,y-1} + \delta_3 \Delta RGDP_{i,y} + \delta_4 openess_{i,y} + \delta_5 D.regime_{i,ym} \\ & + \eta_1 \Delta VIX_t^h + D.year + D.country + \epsilon_{i,t}^h.\end{aligned} \tag{2}$$

[1] Swanson (2021) identified exogenous monetary policy shocks by estimating the factor model, $X = F\Lambda + \epsilon$, using a principal component analysis. The matrix X represents a vector of financial variables, including the interest rates of different maturities, stock market indices, and exchange rates for major currencies. Under the assumption of an efficient market, any changes in financial variables of X during a narrow window around the FOMC announcement would indicate unanticipated changes in the U.S. monetary policy stance, which allows us to identify the shocks in monetary policy. In this context, the matrix F could be interpreted as monetary policy shocks. To ensure that the three factors of F truly represent FFR_t, FG_t, and $LSAP_t$, they additionally impose the following three identifying assumptions. The second factor of F has no impact on the spot Federal Funds rate, which is contained in the matrix X. Furthermore, the third factor of F does not impact the spot Federal Funds rate. Lastly, the variation in the third factor is minimized over the sample period preceding the Global Financial Crisis. In this context, the three factors of F correspond to FFR_t, FG_t, and $LSAP_t$ shocks.

The sample consists of 4,626 observations covering 148 FOMC meetings between January 3, 2001, and June 19, 2019, for 34 countries. The start date reflects improved coverage of gross liability data, while the end date corresponds to the availability of the monetary policy shocks in Swanson (2021). Countries included in the sample must have data available for at least 80 percent of FOMC announcement dates.[2] We exclude euro area countries due to difficulties in measuring common foreign liabilities, as well as special administrative regions such as Hong Kong, though results are robust to their inclusion. The following is the list of sample countries grouped by region:

- North and South America: Argentina, Brazil, Canada, Chile, Colombia, Mexico, Peru, Uruguay
- Asia and Oceania: Australia, India, Indonesia, Japan, Korea, Malaysia, New Zealand, Philippines, Singapore, Thailand
- Africa and Middle East: Bahrain, Israel, South Africa, Turkey
- Europe: Bulgaria, Czech, Denmark, Hungary, Iceland, Norway, Poland, Romania, Russia, Sweden, Switzerland, United Kingdom

Table 1 reports summary statistics for the main variables. Panel A summarizes monetary policy shocks. Monetary policy shocks are normalized so that a one-unit increase represents 1 percentage point increase in the shock. A one standard deviation of FFR is approximately 5 basis points. The small magnitude reflects the zero lower bound (ZLB) constraint during much of the sample. Similarly, a one standard deviation of FG is equivalent to 6 basis points in 4-quarter-ahead Eurodollar futures.

Panels B–D report exchange rate and macroeconomic statistics. Panel B presents the full sample, while Panels C and D split the sample by the median of average log foreign liabilities. Countries with high foreign liabilities display larger exchange rate responses to

[2] Although the threshold of 80% is somewhat ad-hoc, the main results remain unaffected by alternative thresholds.

U.S. monetary policy shocks (i.e., larger standard deviation of exchange rate changes after FOMC events), consistent with our core hypothesis.

Table 1: Summary statistics

	variable	mean	sd	min	p25	median	p75	max
Panel A: monetary policy shock								
number of FOMC meetings = 148	MPS_t^{orth} (%)	0.00	0.05	-0.23	-0.03	0.00	0.03	0.16
	FFR_t (%)	0.00	0.05	-0.39	0.00	0.01	0.02	0.12
	FG_t (%)	0.00	0.06	-0.19	-0.03	0.00	0.03	0.25
Panel B: full sample								
nobs = 4,626	$\Delta E_t^{h=1}$ (%)	-0.18	1.05	-3.90	-0.68	-0.09	0.32	2.86
	$\Delta E_t^{h=5}$ (%)	-0.05	1.64	-4.88	-0.89	0.00	0.76	5.12
	$\Delta E_t^{h=10}$ (%)	0.17	2.16	-5.65	-0.98	0.01	1.23	7.56
	$\Delta E_t^{h=20}$ (%)	0.14	2.89	-7.03	-1.50	0.00	1.53	10.27
	$\Delta E_t^{h=30}$ (%)	0.09	3.79	-8.75	-2.08	-0.03	1.73	14.44
	$liab$ (ln)	7.43	1.35	3.96	6.57	7.32	8.26	11.31
	$\Delta RGDP$ (%)	3.38	2.99	-10.89	1.80	3.25	5.22	14.52
	$GDPPC$ (%)	9.57	1.07	6.63	8.79	9.41	10.60	11.37
Panel C: low foreign liability country								
nobs = 2,292	$\Delta E_t^{h=1}$	-0.15	1.01	-3.90	-0.57	-0.03	0.27	2.86
	$\Delta E_t^{h=5}$	-0.04	1.61	-4.88	-0.80	0.00	0.68	5.12
	$\Delta E_t^{h=10}$	0.17	2.13	-5.65	-0.86	0.00	1.08	7.56
	$\Delta E_t^{h=20}$	0.15	2.85	-7.03	-1.40	0.00	1.42	10.27
	$\Delta E_t^{h=30}$	0.11	3.69	-8.75	-1.82	0.00	1.65	14.44
	$liab$ (ln)	6.42	0.78	3.96	5.98	6.60	6.97	7.74
	$\Delta RGDP$	3.68	3.06	-10.89	2.21	4.06	5.70	10.43
	$GDPPC$	9.25	0.82	7.52	8.65	9.19	9.77	10.96
Panel D: high foreign liability country								
nobs = 2,334	$\Delta E_t^{h=1}$	-0.21	1.10	-3.90	-0.78	-0.17	0.38	2.86
	$\Delta E_t^{h=5}$	-0.06	1.67	-4.88	-0.97	-0.05	0.88	5.12
	$\Delta E_t^{h=10}$	0.17	2.18	-5.65	-1.10	0.04	1.37	7.56
	$\Delta E_t^{h=20}$	0.13	2.93	-7.03	-1.59	-0.03	1.63	10.27
	$\Delta E_t^{h=30}$	0.08	3.88	-8.75	-2.21	-0.24	1.84	14.44
	$liab$ (ln)	8.42	1.01	6.37	7.78	8.25	9.03	11.31
	$\Delta RGDP$	3.08	2.88	-7.80	1.59	2.83	4.79	14.52
	$GDPPC$	9.88	1.20	6.63	9.08	10.42	10.81	11.37

Note: The table presents the summary statistics of key variables for different groups of sample countries. We calculate the country average of the logarithm of foreign liabilities. The "low" group refers to the bottom half; the "high" group refers to the top half. ΔE_t^h and ΔVIX_t^h is winsorized at the top and bottom 1%.

2.2 Suggestive evidence

We provide preliminary evidence that countries with larger foreign liabilities exhibit stronger exchange rate responses to U.S. monetary policy shocks. To illustrate this relationship, we estimate the following regression separately for each country:

$$\Delta E_t^{h=1} = \beta_0 + \beta_1 MPS_t^{orth} + \epsilon_t,$$

where $\Delta E_t^{h=1}$ denotes the one-day exchange rate change around FOMC announcements, and MPS_t^{orth} is the exogenous monetary policy surprise.

Using the estimated β_1 coefficients across countries, we examine their correlation with average log foreign liabilities. Figure 1 displays a positive relationship between the magnitude of the exchange rate response and the size of foreign liabilities. This pattern persists across alternative horizons ($h = 5, 10, 20, 30$), suggesting that countries with greater external liabilities tend to experience larger exchange rate movements in response to U.S. monetary policy shocks.

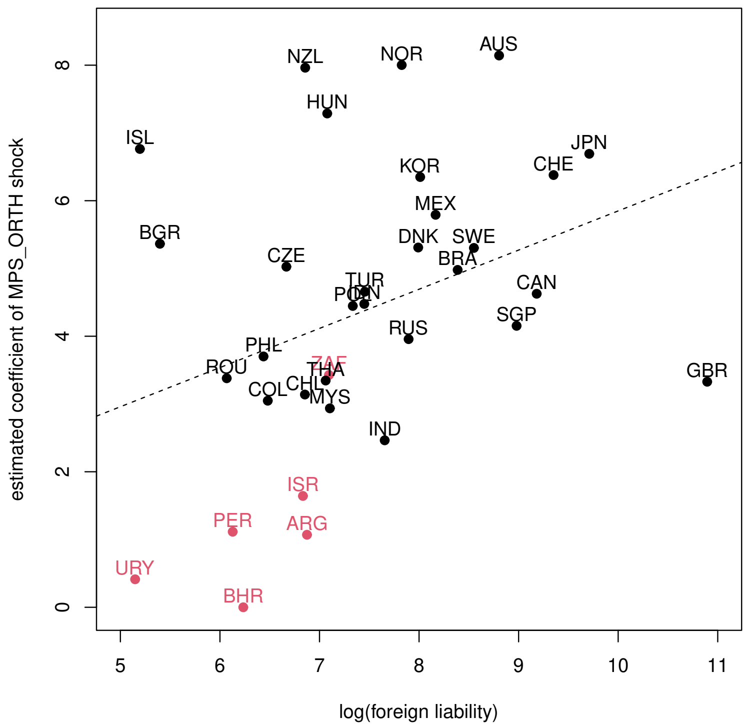
2.3 Main findings

In this section, we formally test the hypothesis that the magnitude of a country's foreign liabilities affects the sensitivity of its exchange rate to U.S. monetary policy shocks. We implement the empirical strategy outlined in Section 2.1.

We begin by estimating the baseline model without the interaction between monetary policy shocks and foreign liabilities. This specification isolates the average exchange rate response to exogenous U.S. monetary policy shocks. Figure 2 presents the estimated coefficients over horizons ranging from $h = 1$ to $h = 25$ days, using the benchmark monetary policy surprise (MPS_t^{orth}), as well as decomposed surprises from conventional (FFR_t) and unconventional (FG_t) monetary policy instruments. Shaded areas denote one- and two-standard deviation confidence intervals, with standard errors clustered at the FOMC announcement level.

Across most horizons, the estimated coefficients are positive, indicating that a contractionary U.S. monetary policy shock leads to a depreciation of foreign currencies. Thus, we

Figure 1: Country-by-country regression

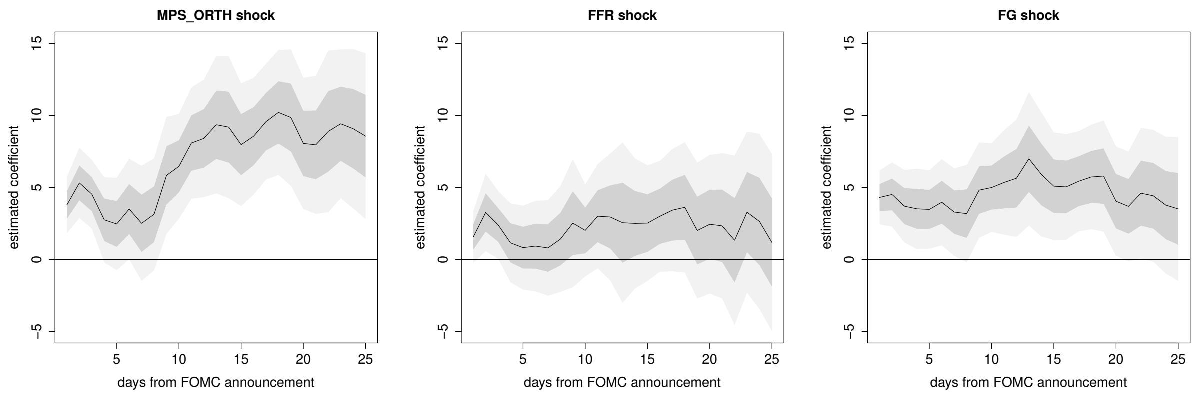


Note: This figure plots the estimated response of the exchange rate to U.S. monetary policy surprises against the country-level average of log foreign liabilities. Each dot represents a country-specific estimate from $\Delta E_t^{h=1} = \beta_0 + \beta_1 MPS_t^{orth} + \epsilon_t$. Red dots indicate coefficients that are statistically insignificant at the 10% level.

find no evidence of an exchange rate puzzle over the horizons considered. Notably, the response is more pronounced and more precisely estimated for FG_t relative to FFR_t, echoing the findings of Hausman and Wongswan (2011), who emphasize that exchange rates respond more strongly to forward guidance than to changes in the spot policy rate.

Next, we turn to the full specification, which allows for the exchange rate response to vary with the level of gross foreign liabilities. Table 2 reports the results for the benchmark model, while Table 3 shows estimates from the extended specification that distinguishes between conventional and unconventional monetary policy shocks. To conserve space, we report results for selected horizons: $h = 1, 5, 10, 20, 30$. Although our analysis focuses on high-frequency exchange rate movements, we include $h = 30$ to capture the persistence of

Figure 2: Response of exchange rates to exogenous U.S. monetary policy tightening



Note: This figure plots the estimated coefficients on MPS_t^{orth}, FFR_t, and FG_t from specifications that exclude interaction terms with foreign liabilities. Each panel reports estimates for varying values of h, the horizon in days after the FOMC announcement. Shaded bands denote one- and two-standard deviation confidence intervals. Standard errors are clustered at the FOMC date level.

the effects. This choice reflects the finding, shown in Figure 2, that the statistical significance of FG_t shocks diminishes beyond $h = 25$.

Table 2 reveals that the interaction between MPS_t^{orth} and foreign liabilities is positive and statistically significant for most horizons. These results indicate that the depreciation of foreign currencies in response to U.S. monetary tightening is larger for countries with higher levels of external liabilities.

Table 3 further decomposes this relationship and shows that the amplification effect is primarily driven by unconventional monetary policy. The interaction between FG_t and foreign liabilities is consistently positive and statistically significant for all horizons except $h = 30$. In contrast, the interaction with FFR_t is smaller and generally statistically insignificant. To gauge the economic magnitude of these effects, consider the distribution of foreign liabilities in the sample. The standard deviation of the log of gross foreign liabilities is 1.35. For countries with foreign liabilities one standard deviation below the mean, a one percentage point increase in FG_t results in an exchange rate response ranging from 2.08% to 2.93%, depending on the time horizon. In contrast, for countries with foreign liabilities one standard deviation above the mean, the same shock induces a depreciation between 5.18% and 7.65%. These

Table 2: Foreign liabilities and U.S. monetary policy

	h=1	h=5	h=10	h=20	h=30
MPS_t^{orth}	4.02***	2.60	6.76***	8.33***	9.93***
	(4.06)	(1.56)	(3.65)	(3.64)	(3.01)
$MPS_t^{orth} \times liab_{i,y-1}$	1.08***	0.68	1.36**	1.30**	1.12
	(3.67)	(1.47)	(2.46)	(2.26)	(1.39)
$liab_{i,y-1}$	-0.086	0.15	0.43**	0.61**	1.01***
	(-0.91)	(1.21)	(2.37)	(2.42)	(3.46)
Adjusted R^2	0.154	0.072	0.110	0.131	0.179
Observations	4626	4626	4626	4626	4626

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: This table summarizes the baseline estimation results of equation (1) for different values of h. Standard errors are clustered at the FOMC date level.

Table 3: Foreign liabilities and conventional vs. unconventional U.S. monetary policy

	h=1	h=5	h=10	h=20	h=30
FFR_t	1.55*	0.57	1.60	2.23	4.00
	(1.79)	(0.36)	(0.95)	(0.88)	(1.04)
$FFR_t \times liab_{i,y-1}$	0.43*	-0.24	-0.50	-0.037	-0.17
	(1.93)	(-0.56)	(-1.01)	(-0.07)	(-0.19)
FG_t	4.48***	3.65***	5.29***	4.28**	3.64
	(4.88)	(2.66)	(3.49)	(2.26)	(1.27)
$FG_t \times liab_{i,y-1}$	1.30***	1.13***	1.75***	1.63***	0.77
	(4.80)	(2.74)	(3.62)	(3.02)	(0.91)
$liab_{i,y-1}$	-0.081	0.16	0.43**	0.62**	1.01***
	(-0.87)	(1.26)	(2.41)	(2.44)	(3.46)
Adjusted R^2	0.183	0.083	0.110	0.121	0.168
Observations	4626	4626	4626	4626	4626

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: This table summarizes the baseline estimation results of equation (2) for different values of h. Standard errors are clustered at the FOMC date level.

results highlight the heterogeneous transmission of U.S. monetary policy across countries with differing exposure to external liabilities.

2.4 Robustness Checks

High vs. middle-income economies. We begin by addressing whether the baseline findings reported in Table 3 may be driven by differences in the income group. Given the systematic variation in foreign liability levels between high- and middle-income countries documented in Figure 1, the observed greater depreciation in response to unconventional U.S. monetary policy in countries with higher liabilities may simply reflect this group-level distinction. To address this concern, we estimate equation (2) separately for high- and middle-income country samples following the World Bank classification. As shown in Table A1 in the appendix, the foreign liability channel remains operative within each group, indicating that the results are not driven solely by income classification.

FOMC-fixed effect. Second, we replace both types of monetary policy shocks—FFR_t and FG_t—with FOMC date fixed effects. In the baseline specification, the average effect of monetary policy is assumed constant across FOMC dates, as reflected in constant β_1 and β_2 in equation (2). Including FOMC date fixed effects allows these average effects to vary across meetings and controls for any unobserved common shocks associated with specific FOMC announcements that could influence exchange rate movements globally. While this specification absorbs the direct effects of FFR_t and FG_t, the estimated interaction terms continue to reveal that the impact of FG_t increases with foreign liabilities in Table A2.

Foreign assets vs. liabilities. Third, we include an interaction between monetary policy shocks and the log of foreign assets, alongside the baseline interaction with foreign liabilities. Because foreign assets and liabilities are positively correlated, failing to distinguish between the two may confound their individual contributions. Table A3 confirms that the heterogeneous exchange rate response to FG shocks is primarily driven by foreign liabilities, not by assets, suggesting the importance of domestic market depth relevant for foreign investors.

Foreign reserves. Fourth, we control for the potential role of foreign reserves by interacting monetary policy shocks with the ratio of foreign reserves to GDP, alongside the foreign liabilities interaction. This robustness check is motivated by Chen et al. (2016) and Ahmed et al. (2023), who highlight the buffer role of reserves in the transmission of U.S. monetary policy. As reported in Table A4, the central finding—that the exchange rate response to FG shocks increases with foreign liabilities—remains robust.

Foreign currency intervention. Fifth, we examine whether the observed relationship between foreign liabilities and exchange rate sensitivity could be confounded by foreign currency intervention (FXI). Countries that actively manage their currencies are often associated with lower levels of foreign liabilities, due to tighter capital flow restrictions. Moreover, previous work (e.g., Kim (2003)) has documented weaker transmission of U.S. monetary policy in countries with active FX intervention aimed at dampening exchange rate volatility.

To account for this, we interact each monetary policy shock—FFR_t and FG_t—with a country-level measure of foreign currency intervention, "Total FXI Proxied in percentage points" ($FXI_{i,ym}$), as constructed by Adler et al. (2024).[3] Table A5 summarizes the results. The coefficients on the interaction between FG_t and $liab_{i,t-1}$ remain positive and statistically significant for all horizons except $h = 30$, reinforcing the conclusion that foreign liabilities are a key determinant of exchange rate sensitivity even after accounting for FX intervention.

Other compounding factors. Sixth, we explore the robustness of our results to additional confounding variables by interacting monetary policy shocks with several alternative country characteristics: the share of dollar invoicing (as highlighted in Zhang (2022) and Ca'Zorzi et al. (2023)), the log of foreign assets net of reserves, the log of foreign reserves, and FX trading volume from BIS. To conserve space, we report results only for $h = 1$. As shown in Table A6, the forward guidance channel remains significantly associated with foreign liabilities.

Role of COVID-19. Lastly, we investigate whether the relationship between foreign liabilities and exchange rate responses changed during the COVID-19 pandemic. Given the

[3]Bahrain and Iceland are excluded from this specification due to missing FXI data.

unprecedented expansionary stance of U.S. monetary policy during 2020–21 and the sharp reversal in 2022 in response to inflationary pressures, the sensitivity of exchange rates to monetary shocks may have evolved. To test for this, we re-estimate equation (1) using data through December 2022. Because data on conventional and unconventional monetary policy shocks are only available through June 2019, we focus this exercise on total monetary shocks MPS_t^{orth}. Table A7 presents the estimation results. We find no evidence of a structural change in the relationship between foreign liabilities and exchange rate sensitivity following the onset of the pandemic.

3 Theoretical Explanation

This section outlines a tractable two-country, two-period model to investigate the moderating role of market depth in shaping the short-run response of exchange rates to U.S. monetary policy shocks. This analytical structure is consistent with a well-established strand of the literature, as it allows for closed-form solutions for the equilibrium real exchange rate (e.g., Aizenman, 1983; Van Wijnbergen, 1986; Tille and van Wincoop, 2014; Davis and Van Wincoop, 2018). We closely follow the environment described in Bacchetta and Van Wincoop (2021). Although our empirical analysis focuses on nominal exchange rates, we model the real exchange rate due to our interest in high-frequency fluctuations, where price level movements are negligible, implying near-equivalence of real and nominal exchange rate dynamics in the short run.

3.1 Benchmark model

The model features overlapping generations of households who live for two periods. There are two countries, indexed by $h = H, F$, and two financial assets: home and foreign bonds.

Home households born at time t maximize expected lifetime utility:

$$C_{H,t} + \ln(E_t C_{H,t+1}^{1-\gamma})^{\frac{1}{1-\gamma}} - 0.5\psi(z_{H,t} - z_{H,t-1})^2 \tag{3}$$

where $C_{H,t}$ denotes consumption and $z_{H,t}$ is the portfolio share invested in foreign bonds. Utility is quasi-linear, with risk aversion parameter γ. Under this specification, savings are fixed at unity, facilitating the tractable derivation of equilibrium conditions.

The final term represents a quadratic portfolio adjustment cost, capturing disutility from deviating from the prior generation's portfolio share. While we abstract from microfoundations, such frictions may reflect transaction or cognitive costs associated with portfolio changes, consistent with Gârleanu and Pedersen (2013) and Bacchetta et al. (2022). Importantly, we assume the adjustment cost ψ declines with the depth of the home bond market, proxied by the steady-state share of foreign liabilities $\bar{z}_H$, reflecting the observation that deeper markets entail lower transaction costs (Demsetz, 1968; Stoll, 2000).[4]

$$\psi = \frac{(\tilde{z}_H - \bar{z}_H)^{\nu_1}}{\nu_2}, \tag{4}$$

where $\tilde{z}_H$ denotes the upper bound for $\bar{z}_H$, and $\nu_1 > 1$, $\nu_2 > 0$ are parameters.

The intertemporal budget constraint is:

$$C_{H,t+1} = R_{t+1}^{p,H}(Y_{H,t} - C_{H,t}), \tag{5}$$

where $R_{t+1}^{p,H}$ is the gross portfolio return and $Y_{H,t}$ is a fixed endowment. Since income $Y_{H,t}$ is irrelevant when deriving the equilibrium exchange rate below, we assume that a fixed amount of endowment is given to households.

[4]When financial markets are deep and liquid, a large number of participants are willing to buy and sell assets, thereby narrowing bid-ask spreads and allowing transactions to occur closer to the prevailing market price. This, in turn, reduces transaction costs (Copeland and Galai, 1983; Glosten and Milgrom, 1985). Moreover, because the steady-state portfolio share of foreign agents in home bonds, $1 - \bar{z}_F$, equals $\bar{z}_H$ by symmetry, adjustment costs decline in the level of foreign liabilities.

Portfolio returns are given by:

$$R_{t+1}^{p,H} = \left[z_{H,t} \frac{S_{t+1}}{S_t} e^{i_t^*} + (1 - z_{H,t}) e^{i_t} \right] \frac{P_t}{P_{t+1}}, \tag{6}$$

with i_t and i_t^* denoting home and foreign nominal interest rates, P_t the home CPI, and S_t the nominal exchange rate, expressed as the price of foreign currency in terms of the home currency.

Substituting (5) into (3) and solving yields the optimal portfolio allocation:

$$z_{H,t} - \bar{z}_H = \frac{\psi}{\psi + \gamma \sigma^2} (z_{H,t-1} - \bar{z}_H) + \frac{1}{\psi + \gamma \sigma^2} E_t e r_{t+1} \tag{7}$$

where $er_{t+1} = s_{t+1} - s_t + i_t^* - i_t$ is the excess returns and $\sigma^2 = \mathrm{Var}_t(s_{t+1})$. For a detailed derivation and discussion of the model, refer to Appendix B.

Foreign households solve an analogous problem, yielding:

$$z_{F,t} - \bar{z}_F = \frac{\psi}{\psi + \gamma \sigma^2} (z_{F,t-1} - \bar{z}_F) + \frac{1}{\psi + \gamma \sigma^2} E_t e r_{t+1}. \tag{8}$$

Let $r_t = i_t - E_t \pi_{t+1}$ and $r_t^* = i_t^* - E_t \pi_{t+1}^*$ denote the real interest rates, and $r_t^D = r_t^* - r_t$ the real rate differential. Given $E_t e r_{t+1} = E_t q_{t+1} - q_t + r_t^D$ and bond market clearing, the equilibrium real exchange rate satisfies:

$$E_t q_{t+1} - \theta q_t + b \psi q_{t-1} + r_t^D = 0, \tag{9}$$

with $\theta = 1 + \psi b + \gamma \sigma^2 b$ and $b = 0.5 \bar{z}_H$.

Solving (9), the equilibrium exchange rate is:

$$q_t = \alpha q_{t-1} + E_t \sum_{i=0}^{\infty} \frac{1}{D^{i+1}} r_{t+i}^D, \tag{10}$$

where

$$\alpha = \frac{\theta - \sqrt{\theta^2 - 4\psi b}}{2}, \tag{11}$$

$$D = \frac{\theta + \sqrt{\theta^2 - 4\psi b}}{2}. \tag{12}$$

and $0 \leq \alpha < 1$, $D > 1$. The real exchange rate is determined by its lag and the present discounted value of expected future real interest rate differentials.

To incorporate forward guidance, we model real interest rates as an autoregressive process:

$$r_{t+1} = \rho r_t + \varepsilon_{t+1} + e_t, \quad r^*_{t+1} = \rho r^*_t + \varepsilon^*_{t+1} + e^*_t, \tag{13}$$

where the persistence parameter $\rho \in (0, 1)$ is assumed to be identical across countries for simplicity, ε_t is a contemporaneous shock, and e_t is a news shock about the future interest rate arriving one period ahead of its actual impact on the interest rate.[5] Following Bacchetta and Van Wincoop (2021), we calibrate the model at a monthly frequency. Additional details are provided in Appendix B.3.

3.2 Propagation mechanisms: foreign liabilities and exchange rate dynamics

This section provides a structural interpretation of the empirical findings presented in Section 2. Specifically, we examine how the exchange rate responds to a foreign interest rate shock—interpreted as a U.S. monetary policy shock—under varying levels of steady-state foreign portfolio liabilities, defined as the fraction of domestic bonds held by foreign households.[6]

To highlight the role of market depth in shaping the transmission of U.S. monetary policy shocks, we simulate exchange rate dynamics for two economies that differ in their size

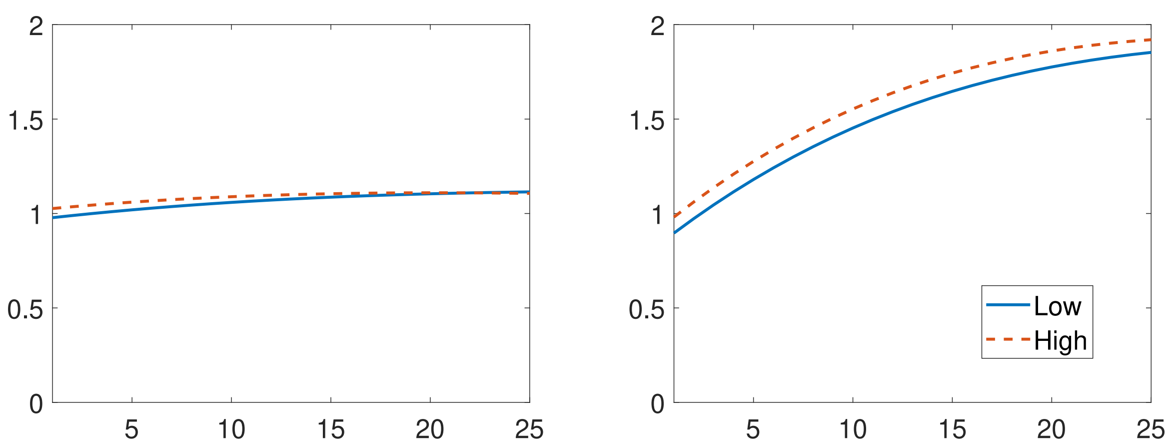
[5] We omit the constant term in the autoregressive processes, assuming that steady-state interest rates are identical across both countries to facilitate the analysis.

[6] In the model, the sizes of foreign assets and liabilities evolve symmetrically due to symmetry between home and foreign households.

of foreign liabilities: one with a high level ($\bar{z}_H = 0.42$) and one with a low level ($\bar{z}_H = 0.07$).[7] Because the two economies differ in their degree of foreign liabilities, they also differ in the parameters α and D that govern exchange rate dynamics in equation (10). In particular, both parameters are larger in the low-liability economy: $\alpha_{high} < \alpha_{low}$ and $D_{high} < D_{low}$.

We introduce a one percent positive foreign interest rate shock at time zero, separately capturing spot and anticipated (news) components—representing FFR and forward guidance (FG) shocks, respectively. To ensure consistency with the empirical impulse response functions, particularly those in Figure 2, we interpolate the simulated responses to a daily frequency using a cubic spline.

Figure 3: Exchange rate responses to foreign interest rate shocks



Note: This figure shows the impulse responses of the real exchange rate to a spot interest rate shock (left) and a news interest rate shock (right). The red dotted and blue solid lines represent the responses in countries where $\bar{z}_H$ equals 0.42 and 0.07, respectively. The horizontal axis represents the number of days after the shock.

As shown in Figure 3, the simulated impulse responses reveal that exchange rate reactions are more pronounced in the high-liability country. This disparity is particularly evident in response to the forward guidance (FG) shock, whereas the responses to the federal funds rate (FFR) shock are more comparable between countries. These patterns are consistent with the

[7]The values $\bar{z}_H = 0.07$ and $\bar{z}_H = 0.39$ correspond to one standard deviation below and above the cross-country mean in the BIS dataset, as discussed in Appendix B.3. These values approximate the levels observed in the Philippines or Mexico, and in Switzerland, respectively.

empirical estimates documented earlier.

Why does liability matter more for the FG shock than for the FFR shock? The key mechanism lies in the difference in the impact coefficient D. In (10), as i increases, the gap between $1/D^i_{high}$ and $1/D^i_{low}$ widens, implying that the influence of D becomes more pronounced for shocks that materialize in the future. In the case of an FG shock, which affects the expected path of the interest rate differential, the exchange rate response is more heavily discounted by the $1/D$ term, since the shock is realized with a delay (see B9 and B10). As a result, discounting compounds more strongly in the FG case, amplifying the differential response between high- and low-liability countries over time.

By contrast, for an FFR shock, the discounting mechanism is relatively weak. The larger immediate exchange rate response in the high-liability country is gradually offset by the delayed—but more persistent—response in the low-liability country. In the FG case, however, the stronger discounting associated with delayed realization sustains a larger and more persistent differential in exchange rate responses, even as the low-liability country's exchange rate adjusts with a lag over the horizon considered.

In addition, the FG shock exerts a greater overall effect on the exchange rate than the FFR shock within the relevant horizon. The exchange rate reflects the expected discounted sum of future interest rate differentials. An FFR shock affects the current differential directly, with subsequent differentials discounted at a constant rate of ρ/D. In contrast, an FG shock alters expectations about future differentials, generating an exchange rate response even before the interest rate changes. In addition to the inertia caused by the front-loaded expectational effect, the actual interest rate hike further increases the expected sum of differentials in the next period. This combination of front-loaded expectation effects and actual interest differentials drives the exchange rate significantly higher compared to the FFR shock.

Furthermore, the model accounts for both short- and long-run differences in exchange rate responses to U.S. monetary policy shocks. Prior research has emphasized that countries with lower financial depth are more exposed to external shocks, including those originating from U.S. monetary policy. At first glance, this may seem at odds with the sharper short-run exchange rate responses observed in high-liability countries. However, our model reconciles these findings by incorporating realistic portfolio adjustment costs linked to foreign asset holdings. As shown in Figure 3, the key distinction between the two country types lies in the share of wealth invested abroad, which tends to be higher in advanced economies. This distinction gives rise to heterogeneity in portfolio adjustment costs, as previously discussed. Figure 3—especially the left panel—clearly illustrates that exchange rate responses are initially more pronounced in countries with higher foreign liabilities. However, these responses decay more rapidly, while countries with smaller foreign liabilities exhibit slower but more persistent exchange rate movements.[8] In sum, the model predicts that countries experiencing a larger immediate depreciation in response to a monetary policy shock will ultimately undergo smaller depreciations over time, while countries with more muted short-run responses will experience more persistent currency adjustments.

4 Conclusion

The growing influence of the Federal Reserve in global financial markets has heightened the importance of understanding the international spillovers of U.S. monetary policy. This paper contributes to the literature by documenting a novel empirical relationship between foreign portfolio liabilities and short-run exchange rate responses to U.S. monetary tightening. Using high-frequency data around FOMC announcements, we show that countries with larger foreign portfolio liabilities experience significantly greater currency depreciation following contractionary U.S. monetary policy shocks. This effect is most pronounced for forward guidance shocks, consistent with the forward-looking nature of exchange rates.

Importantly, the interaction effect between monetary policy shocks and foreign liabilities is both economically meaningful and statistically significant in the short run but diminishes

[8] Although we omit long-horizon impulse responses for brevity, both spot and news interest rate shocks exhibit persistent effects on the exchange rate in low-liability countries, whereas their impacts are front-loaded in high-liability countries.

within a month. This time profile helps explain why previous studies using lower-frequency data have not identified the relationship.

To interpret these findings, we extend the portfolio adjustment model of Bacchetta and Van Wincoop (2021) by introducing a realistic form of portfolio adjustment costs that vary inversely with market depth and a news shock to the future interest rate. This extension provides a theoretical foundation for our empirical results. As deeper financial markets imply lower transaction costs, international investors can rebalance more readily in response to shocks, amplifying the initial exchange rate adjustment.

Our framework reconciles apparent contradictions in the literature by distinguishing between short-run and long-run exchange rate dynamics. It highlights the role of portfolio frictions in shaping high-frequency exchange rate movements. These results offer new insight into the transmission of monetary policy across borders and highlight the importance of market depth in mediating the speed and magnitude of exchange rate adjustments.

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Appendix

A Robustness checks

Table A1: Robustness check: high vs. middle-income countries

Panel A: High-income countries

	h=1	h=5	h=10	h=20	h=30
FFR_t	1.58*	0.43	1.86	1.50	3.31
	(1.67)	(0.27)	(1.09)	(0.66)	(0.89)
$FFR_t \times liab_{i,y-1}$	0.48*	-0.22	-0.80*	-0.52	-0.91
	(1.68)	(-0.53)	(-1.82)	(-1.01)	(-1.02)
FG_t	4.64***	3.35**	5.25***	3.81**	4.43
	(4.73)	(2.43)	(3.29)	(2.06)	(1.57)
$FG_t \times liab_{i,y-1}$	1.04***	0.88**	1.30***	0.95	0.13
	(3.58)	(2.24)	(2.62)	(1.63)	(0.16)
$liab_{i,y-1}$	0.0059	0.26	0.46**	0.71**	1.01***
	(0.06)	(1.34)	(1.99)	(2.32)	(2.73)
Adjusted R^2	0.187	0.091	0.132	0.132	0.174
Observations	2588	2588	2588	2588	2588

Panel B: Middle-income countries

	h=1	h=5	h=10	h=20	h=30
FFR_t	0.88	-0.11	1.42	5.88	8.71
	(0.83)	(-0.06)	(0.53)	(1.34)	(1.47)
$FFR_t \times liab_{i,y-1}$	-0.073	-0.83	-0.071	2.81	3.41
	(-0.13)	(-1.01)	(-0.07)	(1.53)	(1.33)
FG_t	5.03***	5.22***	6.77***	7.10***	3.40
	(5.10)	(3.08)	(3.74)	(2.78)	(0.88)
$FG_t \times liab_{i,y-1}$	2.26***	2.77***	3.71***	4.89***	1.97
	(3.80)	(2.70)	(3.43)	(3.63)	(0.98)
$liab_{i,y-1}$	-0.21	0.13	0.57*	0.66	1.08**
	(-1.22)	(0.51)	(1.76)	(1.58)	(2.13)
Adjusted R^2	0.188	0.088	0.091	0.117	0.162
Observations	2038	2038	2038	2038	2038

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: This table reports the estimation results of equation (2), with the sample divided by income group based on the World Bank classification. Panel A presents results for the high-income country subsample, while Panel B displays results for the middle-income country subsample. Standard errors are clustered at the level of FOMC announcement dates.

Table A2: Robustness check: FOMC-fixed effect

	h=1	h=5	h=10	h=20	h=30
$FFR_t \times liab_{i,y-1}$	0.37**	0.044	-0.23	0.0049	-0.23
	(2.08)	(0.20)	(-0.64)	(0.01)	(-0.43)
$FG_t \times liab_{i,y-1}$	0.75***	0.47*	0.97**	1.08***	0.91*
	(3.80)	(1.78)	(2.56)	(2.62)	(1.75)
$liab_{i,y-1}$	-0.073	0.19	0.47**	0.66**	1.07***
	(-0.78)	(1.41)	(2.56)	(2.53)	(3.53)
Adjusted R^2	0.437	0.383	0.378	0.365	0.434
Observations	4626	4626	4626	4626	4626

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: This table reports the estimation results of equation (2), replacing the FFR_t and FG_t with FOMC date fixed effects. Standard errors are clustered at the level of FOMC announcement dates.

Table A3: Robustness check: controlling for foreign assets

	h=1	h=5	h=10	h=20	h=30
FFR_t	1.55*	0.57	1.60	2.25	4.04
	(1.80)	(0.36)	(0.94)	(0.89)	(1.05)
$FFR_t \times liab_{i,y-1}$	1.56**	1.25	3.03	7.57**	8.47
	(2.03)	(0.83)	(1.46)	(2.36)	(1.50)
$FFR_t \times asset_{i,y-1}$	-1.00	-1.32	-3.12*	-6.71**	-7.60*
	(-1.44)	(-1.07)	(-1.67)	(-2.59)	(-1.70)
FG_t	4.47***	3.64***	5.27***	4.26**	3.64
	(4.88)	(2.66)	(3.48)	(2.25)	(1.28)
$FG_t \times liab_{i,y-1}$	2.56***	2.78**	3.53**	1.96	-3.54
	(2.66)	(2.16)	(2.30)	(0.78)	(-0.95)
$FG_t \times asset_{i,y-1}$	-1.12	-1.47	-1.59	-0.31	3.82
	(-1.40)	(-1.44)	(-1.25)	(-0.15)	(1.30)
$liab_{i,y-1}$	-0.0080	0.12	0.44**	0.50	0.96**
	(-0.07)	(0.74)	(2.03)	(1.51)	(2.56)
$asset_{i,y-1}$	-0.099	0.059	-0.023	0.13	0.025
	(-1.04)	(0.37)	(-0.12)	(0.43)	(0.08)
Adjusted R^2	0.183	0.083	0.111	0.123	0.169
Observations	4626	4626	4626	4626	4626

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: This table reports the estimation results of equation (2), including the additional interaction terms between monetary policy shocks and the logarithm of foreign assets. Standard errors are clustered at the FOMC date level.

Table A4: Robustness check: controlling for foreign reserves

	h=1	h=5	h=10	h=20	h=30
FFR_t	1.59*	0.46	1.29	1.88	3.59
	(1.93)	(0.28)	(0.75)	(0.71)	(0.91)
$FFR_t \times liab_{i,y-1}$	0.44*	-0.27	-0.57	-0.13	-0.28
	(1.83)	(-0.58)	(-1.17)	(-0.25)	(-0.31)
$FFR_t \times reserve_{i,y-1}$	0.83	-1.83	-5.82	-7.37	-9.08
	(0.28)	(-0.54)	(-1.44)	(-1.00)	(-0.90)
FG_t	4.50***	3.68***	5.33***	4.28**	3.59
	(4.92)	(2.70)	(3.52)	(2.28)	(1.26)
$FG_t \times liab_{i,y-1}$	1.30***	1.13***	1.74***	1.62***	0.77
	(4.80)	(2.75)	(3.65)	(3.01)	(0.90)
$FG_t \times reserve_{i,y-1}$	1.10	1.78	1.09	-2.81	-6.88
	(0.64)	(0.84)	(0.42)	(-0.70)	(-1.36)
$liab_{i,y-1}$	-0.082	0.17	0.46**	0.64**	1.05***
	(-0.85)	(1.30)	(2.48)	(2.49)	(3.53)
$reserve_{i,y-1}$	0.050	-0.15	-0.54	-0.60	-1.02*
	(0.31)	(-0.54)	(-1.59)	(-1.29)	(-1.80)
Adjusted R^2	0.182	0.083	0.110	0.121	0.168
Observations	4626	4626	4626	4626	4626

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: This table reports the estimation results of equation (2), including the additional interaction terms between monetary policy shocks and foreign reserve-to-GDP ratio. Standard errors are clustered at the FOMC date level.

Table A5: Robustness check: controlling for foreign currency intervention

	h=1	h=5	h=10	h=20	h=30
FFR_t	1.59*	0.51	1.91	2.60	3.98
	(1.71)	(0.30)	(0.99)	(0.87)	(0.87)
$FFR_t \times liab_{i,y-1}$	0.58*	-0.19	-0.0060	0.73	0.16
	(1.96)	(-0.31)	(-0.01)	(0.81)	(0.11)
$FFR_t \times FXI_{i,ym}$	0.042	0.16	0.66	-0.42	-0.35
	(0.09)	(0.24)	(0.83)	(-0.33)	(-0.23)
FG_t	4.76***	4.10***	5.90***	4.68**	3.70
	(5.05)	(2.82)	(3.76)	(2.33)	(1.18)
$FG_t \times liab_{i,y-1}$	1.77***	1.86***	2.69***	2.32***	1.05
	(5.58)	(3.35)	(4.55)	(3.13)	(0.86)
$FG_t \times FXI_{i,ym}$	-0.20	-0.31	-0.59	-0.53	0.17
	(-0.70)	(-0.65)	(-1.14)	(-0.81)	(0.23)
$liab_{i,y-1}$	-0.069	0.18	0.44**	0.62**	0.97***
	(-0.75)	(1.39)	(2.45)	(2.47)	(3.36)
$FXI_{i,ym}$	-0.0090	-0.024	-0.013	-0.012	0.0013
	(-0.53)	(-0.98)	(-0.39)	(-0.28)	(0.02)
Adjusted R^2	0.191	0.090	0.116	0.130	0.177
Observations	4346	4346	4346	4346	4346

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: This table reports the estimation results of equation (2), including the additional interaction terms between monetary policy shocks and the measure of foreign currency intervention, $FXI_{i,ym}$, obtained from Adler et al. (2024). Standard errors are clustered at the FOMC date level.

Table A6: Robustness checks: other specifications

	Invoicing	net asset	reserve level	FX volume
FFR_t	1.71*	1.57*	1.58*	1.47*
	(1.71)	(1.83)	(1.95)	(1.69)
$FFR_t \times liab_{i,y-1}$	0.25	1.10***	0.31	0.21
	(0.94)	(2.75)	(1.03)	(0.49)
$FFR_t \times Invoicing_{i,y-1}$	0.47			
	(0.17)			
$FFR_t \times netasset_{i,y-1}$		-0.54*		
		(-1.83)		
$FFR_t \times reserve_{i,y-1}$			0.19	
			(0.51)	
$FFR_t \times FXvolume_i$				0.14
				(0.54)
FG_t	5.04***	4.48***	4.50***	4.42***
	(4.58)	(4.88)	(4.96)	(4.84)
$FG_t \times liab_{i,y-1}$	0.85***	1.78***	1.09***	1.43***
	(2.73)	(3.13)	(3.53)	(2.61)
$FG_t \times Invoicing_{i,y-1}$	3.47			
	(1.30)			
$FG_t \times netasset_{i,y-1}$		-0.40		
		(-1.06)		
$FG_t \times reserve_{i,y-1}$			0.31	
			(1.13)	
$FG_t \times FXvolume_i$				-0.078
				(-0.25)
Adjusted R^2	0.204	0.183	0.183	0.188
Observations	2473	4626	4626	4370

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: This table reports the estimation results of equation (2), including the additional interaction terms between monetary policy shocks and (1) the fraction of Dollar invoicing obtained from Zhang (2022), (2) the logarithm of foreign assets net of foreign reserves, (3) the logarithm of foreign reserves, and (4) FX trading volumes sourced from BIS. Standard errors are clustered at the FOMC date level.

Table A7: Robustness check: COVID-19 pandemic (Jan 3, 2001 - Dec 14, 2022)

	h=1	h=5	h=10	h=20	h=30
MPS_t^{orth}	4.03***	2.66	6.62***	8.24***	9.72***
	(4.16)	(1.62)	(3.63)	(3.66)	(2.99)
$MPS_t^{orth} \times liab_{i,y-1}$	1.06***	0.68	1.29**	1.20**	0.94
	(3.70)	(1.50)	(2.38)	(2.10)	(1.18)
$liab_{i,y-1}$	-0.066	0.18	0.42**	0.62**	0.98***
	(-0.73)	(1.46)	(2.40)	(2.53)	(3.38)
Adjusted R^2	0.155	0.074	0.114	0.134	0.177
Observations	4750	4750	4750	4750	4750

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: This table reports the estimation results of equation (2) using the extended sample up to December 2022. Standard errors are clustered at the FOMC date level.

B Model Derivation

B.1 Households' optimality conditions

Since the first-order condition for consumption gives $Y_{H,t} - C_{H,t} = 1$, saving is always one and households invest a wealth of one in home and foreign assets. The first-order condition for the portfolio share is

$$\frac{E_t e^{-\gamma r^{p,H}_{t+1} + s_{t+1} - s_t + i^*_t - \pi_{t+1}} - E_t e^{-\gamma r^{p,H}_{t+1} + i_t - \pi_{t+1}}}{E_t e^{(1-\gamma) r^{p,H}_{t+1}}} - \psi(z_{H,t} - z_{H,t-1}) = 0, \tag{B1}$$

where $\pi_{t+1} = p_{t+1} - p_t$ denotes inflation from time t to $t+1$ and p_t is the log price level. Linearizing around zero values of exponents and evaluating the expectations of exponentials by assuming log normality, the following relationship can be derived:

$$E_t s_{t+1} - s_t + i^*_t - i_t + 0.5 var_t(s_{t+1}) - cov_t(\gamma r^{p,H}_{t+1} + p_{t+1}, s_{t+1}) - \psi(z_{H,t} - z_{H,t-1}) = 0. \tag{B2}$$

A first-order approximation of the log portfolio return can be expressed as

$$r^{p,H}_{t+1} = z_{H,t} er_{t+1} + i_t - \pi_{t+1}, \tag{B3}$$

where the excess returns present $er_{t+1} = s_{t+1} - s_t + i^*_t - i_t$. Substituting (B3) into (B2), the optimal portfolio can be expressed as

$$z_{H,t} - \bar{z}_H = \frac{\psi}{\psi + \gamma\sigma^2}(z_{H,t-1} - \bar{z}_H) + \frac{1}{\psi + \gamma\sigma^2} E_t er_{t+1} \tag{B4}$$

where $\sigma^2 = var_t(s_{t+1})$.[9]

[9] From (B2), the steady-state fraction of asset invested in the Foreign bond by Home agents, $\bar{z}_H$ can be expressed as $\bar{z}_H = \frac{1}{2\gamma} + \frac{\gamma - 1}{\gamma}\frac{\sigma_{s,p}}{\sigma^2}$, where $\sigma_{s,p} = cov_t(s_{t+1}, p_{t+1})$. As agents shift from risk-neutral to risk-averse behavior, second moments influence allocation decisions. Specifically, increased exchange rate volatility leads agents to reduce foreign investment. Conversely, when inflation and exchange rates exhibit stronger co-movement, holding foreign assets helps stabilize purchasing power in the event of inflation, thereby increasing the proportion of assets invested abroad.

The role of parameters ψ and γ can be understood as follows. Investors take expected returns, risk, and the cost of portfolio adjustment into account when they choose their portfolio positions. An increase in ψ indicates a higher portfolio adjustment cost and it makes the optimal portfolio depend more on the past portfolio position rather than on the expected returns. A rise in γ can be considered as investors being more concerned about risk and leads to a lower weight on both the expected returns and the past position.

B.2 Bond market clearing condition

Due to symmetry between home and foreign households, $\bar{z}_F = 1 - \bar{z}_H$ holds. The real supply of bonds is fixed at one in terms of the purchasing power of the respective countries. Let P_t^* be the consumer price index of the foreign country measured in the foreign currency and $Q_t = S_t P_t^* / P_t$ be the real exchange rate. Due to Walras' law, it is sufficient to consider the foreign bond market equilibrium. The value of the foreign bond supply in terms of home purchasing power is Q_t, while the wealth of home and foreign households in terms of home purchasing power is 1 and Q_t, respectively. Then, foreign bond market equilibrium can be expressed as

$$z_{H,t} + z_{F,t} Q_t = Q_t. \tag{B5}$$

Linearizing around the steady-state log real exchange rate, which is zero, the above equation becomes

$$z_t^A = 0.5 + b q_t \tag{B6}$$

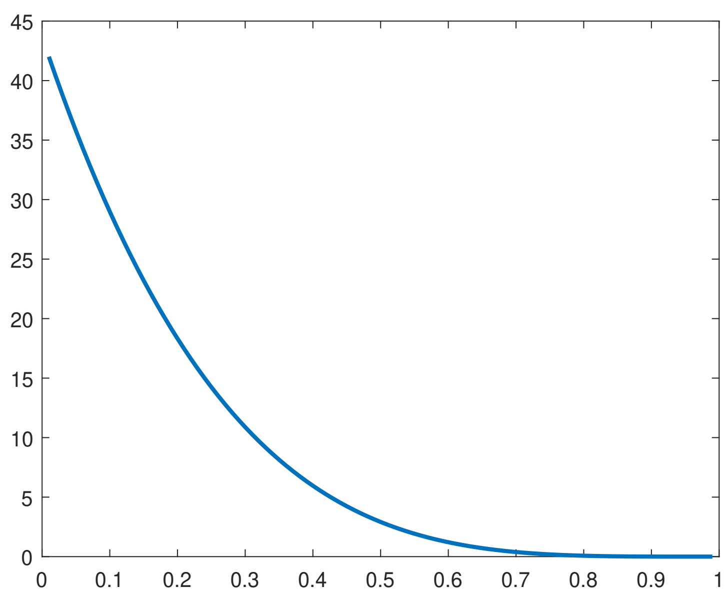
where $z_t^A = 0.5(z_{H,t} + z_{F,t})$ is the average fraction invested in foreign bonds across Home and Foreign.

B.3 Calibration

While six parameters need to be calibrated, two parameters γ and σ are set to 50 and 0.0271, respectively, as in Bacchetta and Van Wincoop (2021). The three of remaining parameters are related to the adjustment cost function ψ. Since the admissible range of $\bar{z}_H$ is less than one, without loss of generality, we set $\tilde{z}_H = 1$. The remaining parameters, ν_1 and ν_2 are calibrated on the cross-country portfolio investment data as outlined below.

We first retrieve cross-border and total liability data from BIS locational banking data. The average values from 2015 to 2019 are used to proxy the steady-state fraction of investment abroad, $\bar{z}_H$. The resulting $\bar{z}_H$ varies from 0.06 to 0.69, with an average value of 0.24 and a standard deviation of 0.18. In addition, as ν_2 determines the overall level of adjustment cost, we set ν_2 so that the adjustment cost, ψ, equals 15, which is the preferred value in Bacchetta and Van Wincoop (2021) when $\bar{z}H$ is at its average value. Finally, ν_1 is chosen to match the observed dispersion in adjustment costs across countries. To achieve this, we collect cross-country equity adjustment cost data from Domowitz et al. (2001) and find the value of ν_1 that matches the dispersion of adjustment costs. As a result, ν_1 and ν_2 are set to 3.85 and 0.022, respectively.

Figure B1: Portfolio adjustment cost as a function of foreign liabilities, $\psi(\bar{z}_H)$



Note: Portfolio adjustment cost ψ is shown as a function of the steady-state foreign liabilities, $\bar{z}_H$.

Figure B1 illustrates the resulting ψ as a function of $\bar{z}_H$. As intended, the adjustment cost decreases in the fraction of investment abroad, which corresponds to the size of foreign liabilities in the empirical analysis. In addition, as targeted, ψ equals to 15 when $\bar{z}_H$ is at its average value, 0.24.

Finally, ρ, the persistence parameter in the interest rate processes, is assumed to be 0.25.

B.4 Impulse response functions

By deriving the responses of the last infinite sum term in Equation (10) to the shocks, we can fully characterize the impulse response of the real exchange rate to those shocks.

By recursively substituting, r_{t+i} can be expressed as:

$$r_{t+i} = \rho^{i+1} r_{t-1} + \rho^i \varepsilon_t + \rho^{i-1} \varepsilon_{t+1} + \cdots + \varepsilon_{t+i} + \rho^i e_{t-1} + \cdots + e_{t+i-1}. \tag{B7}$$

Taking expectations, $\mathbb{E} r_{t+i}$ simplifies to:

$$\mathbb{E} r_{t+i} = \rho^{i+1} r_{t-1} + \rho^i \varepsilon_t + \rho^i e_{t-1} + \rho^{i-1} e_t. \tag{B8}$$

Thus, the infinite sum term in (10) can be rewritten as:

$$E_t \sum_{i=0}^{\infty} \frac{1}{D^{i+1}} r^D_{t+i} = \sum_{i=0}^{\infty} \frac{\rho^{i+1}(r^*_{t-1} - r_{t-1}) + \rho^i(\varepsilon^*_t - \varepsilon_t) + \rho^i(e^*_{t-1} - e_{t-1})}{D^{i+1}} + \sum_{i=1}^{\infty} \frac{\rho^{i-1}(e^*_t - e_t)}{D^{i+1}}. \tag{B9}$$

This infinite sum has an exact analytical solution, given that $0 < \rho/D < 1$:

$$E_t \sum_{i=0}^{\infty} \frac{1}{D^{i+1}} r^D_{t+i} = \frac{\rho}{D-\rho}(r_{t-1} - r^*_{t-1}) + \frac{1}{D-\rho}(\varepsilon^*_t - \varepsilon_t) + \frac{1}{D-\rho}(e^*_{t-1} - e_{t-1}) + \frac{1}{(D-\rho)D}(e^*_t - e_t). \tag{B10}$$